Amendments to the Specification:

Replace paragraphs **[0018]**, **[0019]**, **[0026]**, **[0029]**, **[0031]**, **[0035]**, **[0037]**, **[0040]**, **[0043]**, **[0044]**, **[0049]**, **[0051]**, **[0052]**, **[0054]**, **[0059]**, **[0061]**, **[0062]**, **[0065]**, **[0067]**, **[0068]**, **[0069]**, **[0070]**, **[0071]**, and **[0072]** of the specification of record with the following replacement paragraphs **[0018]**, **[0019]**, **[0026]**, **[0029]**, **[0031]**, **[0035]**, **[0037]**, **[0040]**, **[0043]**, **[0044]**, **[0049]**, **[0051]**, **[0052]**, **[0054]**, **[0059]**, **[0061]**, **[0062]**, **[0065]**, **[0067]**, **[0068]**, **[0069]**, **[0070]**, **[0071]**, and **[0072]** under the provisions of 37 C.F.R. § 1.121(b)(1). No new matter has been added.

[0018] A general solving means according to the present invention is to provide a pulley pressure control system for a transmission in which a pressing force supply path and an elastic force supply path are disposed ~~in parallel~~ with each other, which pressing force supply path is directly led to a pulley through one of two pressing ends of ~~a compound~~ compressing devices and which elastic force supply path is indirectly led to the pulley through the other of the two pressing ends and an elastic body, and elements of a rotation speed and torque are switched between and then individually regulated.

[0019] A first solving means according to the present invention is to provide a pulley pressure control system in which a pressing force supply path for a pressing force and an elastic force supply path for an elastic force are disposed ~~in parallel~~ with each other for an input pulley or an output pulley, an instruction is issued through either one of or both the pressing rce supply path and the elastic force supply path to regulate the pressing force and/or the elastic force to zero or an arbitrary value for selecting a type of pressure.

[0026] An eighth solving means according to the present invention is to provide a pulley pressure control system in which a function switching instruction is issued through an instruction supply path of each pressure application device to synchronously switch between operation modes~~;~~ of a forward mode transmission and a reverse mode ~~in a~~ transmission, based on a position of a belt at an arbitrary speed ratio, a rotation speed or the like.

[0029] In the present invention, a pair of functions, namely, a reference pulley function and a follower pulley function are independently supplied to a driving pulley and a driven pulley, i.e. an input primary pulley and an output secondary pulley. Here, transmission operation in which the reference pulley function is applied to the input primary pulley and the follower pulley function is

applied to the output secondary pulley is defined as a forward mode transmission operation or a normal mode transmission operation. In contrast to this, transmission operation in which the reference pulley function is applied to the output secondary pulley and the follower pulley function is applied to the input primary pulley is defined as a reverse mode transmission operation.

[0031] The pulley functions, namely, the reference pulley function and the follower pulley function can be switched at an arbitrary speed ratio or an outputted rotation speed. While a switching mechanism for switching the pulley functions is indicated as a combination in common use of instruction supply paths for regulating speed change, driving source , and sliding devices described below, these components may be arranged separately. For instance, other switching devices of transmissions, power supply paths, compressing devices and driving sources may be disposed separately. In the case where an outputted rotation speed and torque require the so-called bumpless switching like a vehicle, an engagement device needs completing the displacement of Ir α with high accuracy in a short time upon switching. The reason is that slow switching of the functions brings both the primary and secondary pulleys into an elastic force application state. This shifts the belt to the higher elastic force side pulley, which leads to changing speed. However, it is obvious that a speed ratio or a radius of the belt should not be changed in an unstable state by the elastic force or the semi-elastic force but should be changed and determined by only the pressing force to the reference function pulley. Then, an instruction for making the elastic forces uniform may be applied to both the pulleys. However, in order to shorten an operation time, it is preferable to response to that by a quick instruction of a pulse-driving source that is used to temporarily increase the amount of pulses to be supplied.

[0035] In the following description, various changes and modifications may be applied to devices and components in many ways. Pressure application devices, compound compressing devices, compressing devices, elastic devices or engagement devices may be configured to operate not only in a non-rotary state but also in a rotary state. Also the mounting positions thereof may be arranged not near the pulleys but remotely from the pulleys using a pressure transmission device or the like. As long as the ~~compound~~ compressing devices are able to apply in parallel the elastic force and the pressing force to the movable disk, they may be freely arranged with respect to the elastic devices and the engagement devices. In the case where the

~~compound-~~compressing device is disposed between the movable disk and the elastic device, it is necessary to support the overall ~~compound~~ compressing device in a floating condition so that elastic vibration can be transferred.

[0037] The elastic device may be an elastic body having other forms, such as a coil spring or the like, in addition to a disc or dish spring. The engagement device may include either an engaging portion or guiding portion when switching of the functions is not needed; however, the engagement device needs at least the engaging portion when the switching of the functions is ~~not~~ needed. Sliders, sliding bodies or sliding members constituting the above devices may be used in a sharing manner and replaced with other members, such as a main body, pulley, gear, and lever. A reversible motor may be a DC or AC servomotor, or open-loop stepping motor with or without an encoder depending on uses.

[0040] Referring to FIGS. 2 to 7, there is shown a continuously variable transmission 10 to which a pulley pressure control system 10B is applied according to a first embodiment of the present invention. The continuously variable transmission 10 includes a variable-speed transmission apparatus 10A having an input primary pulley (driving pulley) 1, an output secondary pulley (driven pulley) 2, and a press type belt 3 wound around the primary and secondary pulleys 1 and 2, and the pulley pressure control system 10B, which is a variable-speed ~~controller~~ control system for a transmission for controlling, by means of a control unit 90 shown in FIG. 4, an primary pulley pressure control system 9 and an secondary pulley pressure control system 8 disposed on one plane. In this embodiment, an input side pressure application device 10' includes an input compound compressing device 30, an input elastic device 50, an input engag~~ing~~ment device 55, and two input driving sources 71 and 75. Another output side pressure application device 20 has components generally similar to those of the above input side pressure application device 10', that is to say, an output compound compressing device 40, an output elastic device 60, an output engag~~ing~~ment device 65, and two output driving sources 81 and 85.

[0043] Incidentally, since the same functional components are included in the input side and output side mechanisms in this specification, the terms of "input" or "input side" and "output" or "output side" will be omitted when they are understood from a context or reference numerals except that they will be attached when it is necessary to distinguish the input side from the

output side in a context.

[0044] The variable-speed transmission apparatus 10A includes the two variable pitch pulleys, namely, a primary pulley 1 and a secondary pulley 2 disposed oppositely each other in the arranging direction on an input shaft 1c and an output shaft 2c. The primary pulley 1 has a movable disk 1a and a fixed disk 1b disposed oppositely and the movable disk 1a is slidable, through a key, toward the fixed disk 1b in the axial direction of the pulley 1. Similarly, the secondary pulley 2 has a movable disk 2a and a fixed disk 2b disposed oppositely and the movable disk 2a is slidable, through a key, toward the fixed disk 2b in the axial direction of the pulley 2. The primary pulley 1 is supported by a pair of bearings 5, 5a and 7, and the secondary pulley 2 is supported by a pair of bearings 4, 4a and 6. Between a body 10 and the movable disk 1a is supported by a pair of bearings 5 while separating a rotational force and the pressure application device 10' operatively presses the movable disk 1a. Similarly, between the body 10 and the movable disk 2a is supported by a pair of bearings 4 while separating rotational force and the pressure application device 20 operatively presses the movable disk 2a.

[0049] The input side pressure application device 10' included in the pulley pressure control system 10B is substantially identical to the output side pressure application device 20 in a mechanism and function. The input side pressure application device 10' includes input individual pressure application devices 11 and 31, disposed between the movable disk 1a and the body 10b, which press in series the input elastic device 50 having an input elastic body 51 and the input engagement device 55 individually at two pressing ends of the compound compressing device 30. With this configuration, an input pressing force supply path 55A and an elastic force supply path 50A are arranged in parallel, whereby control elements are individually adjusted. Similarly, the output side pressure application device 20 includes output individual pressure application devices 21 and 41, disposed between the movable disk 2a and the body 10b, which press in series the output elastic device 60 having an output elastic body 61 and the output engagement device 65 individually at two pressing ends of the compound compressing device 40. With this configuration, an output pressing force supply path 65A and an output elastic force supply path 60A are arranged in parallel, whereby the control elements are individually adjusted. As describe above, the basic configuration of the input side pressure application device 10' is the same as that of the output side pressure application device 20. Differences

between the pressure application devices 10' and 20 in construction reside in that the former 10' is formed into an annular shape in an axial direction and disposed coaxially with a shaft 1c; the latter 20 is formed like a massive body without a through hole and disposed coaxially with a shaft 2c behind the fixed disk 2b at a position remote from the movable disk 2a.

[0051] The engagement device 55, which is connected in series to the pressing end 11A, is composed of two sliders 56 and 57. One slider 56 is formed integral with the common sliding member 37. The other 57 applies a pressing force to the movable disk 1a via the slider 56 and the bearing 5. The sliders 56 and 57 have engaging portions 56a and 57a, respectively, which are switchably controlled <u>as a switching device</u> in such a way as to be moved into or out of contact with each other in response to an instruction from the pressing end 11A. In addition, the sliders 56 and 57 have guide portions 56b and 57b, respectively, each of which is formed as a spline member for causing elastic vibration while the sliders 56 and 57 are positioned apart each other. When the sliders 56 and 57 are positioned in contact with each other, the pressing end 11A applies a pressing force to the movable disk 1a, and therefore, the primary pulley 1 performs the reference pulley function. When the engagement between the sliders 56 and 57 is released, a gap with a constant value $1r\alpha_1$ is produced, whereby the application of a pressing force from the pressing end 11A to the movable disk 1a is stopped, and instead of it, the elastic force that is provided in parallel to the pressing force is applied to the movable disk 1a <u>to supply a follower pulley function to the primary pulley 1 thereafter</u>. The slider 57 is retained by the retaining member 54' attached to the body 10B, which prevents the sliding member 37 and the engagement device 55 from rotating.

[0052] The elastic device 50 connected in series to the pressing end 31A includes an elastic body 51, two sliding bodies 53 and 54 that are oppositely placed, a thrust bearing 58, and a seat 59 of the thrust bearing 58. The elastic body 51 is made of eight dish springs, two of which are placed in parallel with each other, which forms four-segment in series. The entire elastic device 50 is disposed concentric with the outer circumference of the engagement device 55. The pressing end 31A, in response to an instruction, provides a gap 52 indicated by a broken line between the seat 59 and the pressing end 31A, which allows supplying pressure to be zero. The elastic body is supported in a floating condition while its elastic vibration cannot be transmitted from one end of the elastic body but can be transmitted from the other. Since the

sliding body 54 is substantially formed integral with the slider 57, the elastic force is applied to the movable disk 1a of the primary pulley 1 together with the pressing force via the bearing 5. The present embodiment is characterized in that the superposing pressing end 31A allows the elastic device to be adjustably pressurized in accordance with a primary instruction and a secondary instruction irrespective of the pressing condition of the pressure supply path 55A composed of the pressing end 11A and the engagement device 55. To be more specific, although the pressure of the engagement device 55 applied to the movable disk 1a is stopped to thereby fix the position of the V-groove of the movable disk 1a, the elastic force is independently supplied to the movable disk 1a. In addition, a frictional force between the belt 3 and the primary pulley 1 can be externally regulated by the application of a semi-elastic force, which is elastic vibration suppressed to a half. Therefore, at this time, the elastic force supply path 50A acts also as a semi-elastic force supply path.

[0054] The output side pressure application device 20 comprises an output compound compressing device 40, an output elastic device 60, an output engag~~ing~~ment device 65 and two output driving sources 80 and 85, similarly to the input side pressure application device 10' in constitution as shown in FIG. 2. Therefore, the duplicate description thereof is omitted and the configurations, of the out~~in~~put side pressure application device 20, different from those of the input side pressure application device 10' will be described below. Here, the same parts in the pressure application device 20 as those in the pressure application device 10' are indicated by reference numerals that are ten greater than the reference numerals of the parts in the pressure application device 10'.

[0059] Next, the operation of the transmission in the first embodiment will be described. An object of this embodiment is to compensate a deterioration in transmission performance and reduction in efficiency in a high-speed range, which are disadvantages of the variable-speed transmission apparatus 10A using the press type belt 3. More specifically, the transmission apparatus 10A operates, in a low-speed range, in the forward mode operation as a first transmission device in which the primary pulley 1 acts as the reference pulley and the secondary pulley 2 acts as the follower pulley, while the transmission 10A operates, in a high-speed range, in the reverse mode operation as a second transmission device in which the primary pulley 1 acts as the follower pulley and the secondary pulley 2 acts as the reference

pulley. An example will be described in the case where a defect specific to the press type belt is overcome by switching operating states on the way of a speed-change range, and regulating torque by compensating an elastic force for each pulley to thereby improve the transmission efficiency.

[0061] (I) Automatic Switching Action of a Forward Mode Transmission Operation and Reverse Mode Transmission Operation:

[0062] An action for automatically switching between the forward mode transmission operation and the reverse mode transmission operation in a speed-change range at an arbitrary predetermined speed ratio ϵ d will be described below. An acceleration instruction includes multiple pulses at a fixed interval. The acceleration instruction includes four instructions, such as input instructions Sr_1 for a rotation-speed control and St_1 for a torque control and output instructions Sr_0 for a rotation-speed control and St_0 for a torque control which are supplied in synchronism with one another. These four instructions are supplied from the control unit 90 through the four driving sources as transmission modes selecting means and the amplifiers 98 to the reversible motors. All the four reversible motors are operated, whereby the input shafts 18a, 38a, 28a and 48a are rotated. On the primary pulley side, the pressing force applied from the compressing device 30 to the primary pulley 1 by the primary instruction Sr1 moves the movable disk 1a in response to the amount of displacement $1r_1$ against the elastic force applied from the compressing device 40 to the secondary pulley 2. At the same time, on the secondary pulley side, an sliding member 27 moves downwardly responsive to the primary instruction Sr_0, and also an sliding member 46 moves downwardly in response to the secondary instruction St_0, whereby a superposing pressing end 41A removes the elastic force of an elastic body 61 by the amount of superposed displacement $1_0(=1r_0+1t_0)$ that is the sum of the amounts of the displacement $1r_0$ and $1t_0$ of both the sliding members 27 and 46.

[0065] Thus, the primary pulley 1 acts as the follower pulley after the pressing force supply has been switched to the elastic force supply; while the secondary pulley 2 acts as the reference pulley after the elastic force supply has been switched to the pressing force supply. Therefore, the transmission apparatus 10A acts as a reverse mode transmission operation. The other speed-change instructions are switched such that, as shown in FIG. 6, the output rotation speed is regulated by the output side primary instruction Sr_0 and the output torque is

regulated by the elastic force applied to the primary pulley 1 by the input side secondary instruction Sti. Consequently, thereafter, stable transmission may be continued in the same manner except that the control unit 90 switches between the control instructions and further between the compensating instructions. When the additional acceleration instruction is supplied, the primary instruction Sr_0 allows a pressing end 21A to give a displacement by the amount of displacement $1r_1$ and the secondary instruction St_0 becomes a pressure instruction for preparing the switching using the semi-elastic force. Further, as with the above description, both the instructions Sr_1 and St_1 on the input side cause the displacement $1r_1$ of the movable disk 1a and the displacement $1t_1$ of the elastic body 51. Consequently, the sum $1_1(=1r_1+1t_1)$ of the amounts of the displacement $1r_1$ and $1t_1$ is supplied to the primary pulley 1 from the superposing pressing end 31A. Thereafter, similarly, the same actions are repeated until a minimum speed ratio ϵ min is attained, resulting in a state of a minimum speed ratio as shown by the right half of the primary pulley 1 and the left half of the secondary pulley in FIG. 2.

[0067] FIG. 7B shows transmission ability characteristics of a speed ratio and a rotation speed. In the press-belt type transmission, at the time of the forward mode operation, the transmitting efficiency becomes worse due to deformation of the belt on the driven ~~follower~~ pulley (output secondary pulley) side in a high-speed range as shown in FIG. 7A. On the other hand, in the present embodiment, the forward mode operation is switched to the reverse mode operation at the speed ratio ϵ d before the high-speed range. This means that both the primary pulley 1 and secondary pulley 2 in the high-speed range is subject to compensation for reinforcing the contact-frictional force. In other words, in the high-speed range, the elastic force applied to the primary pulley 1 as the follow~~ing~~er pulley function is reinforced while the semi-elastic force including the pressing force is applied to the secondary pulley 2 as the reference pulley function so as to positively ensure the frictional force for the secondary pulley 2. It is needless to say that an optimum value of the semi-frictional force is selected from a range where the semi-frictional force is equal to or smaller than the input side frictional force, in order not to change the speed ratio or the radius of the belt predetermined by the primary instruction Sr1 or Sr0. Consequently, depending upon the cooperation with the elastic force to the pulley 1 and the semi-elastic force to the pulley 2, the pressing-deformation of the belt on the secondary pulley side is eliminated and proper torque transmission is carried out due to

tension caused by the input side frictional force and the output side frictional force. In addition, a slip in the high-speed range is eliminated due to the reverse mode operation as indicated by a solid line T_0 in FIG. 7B, whereby the transmitting efficiency is improved over a wide range.

[0068] (II) Forward Mode Transmission Operation in the Overall Speed-Change Range:

[0069] An improvement in the transmission ability of the transmission in the forward mode operation can be effected by only positively, adjustably compensating the frictional force caused by the elastic force of both the pressure application devices 10' and 20. In other words, while the primary pulley 1 performs the reference pulley function in which the pressing force is applied to the primary pulley and the secondary pulley 2 performs the follower pulley function in which the elastic force is applied to the secondary pulley, both the frictional forces are adjustably compensated for synchronously or asynchronously over the speed-change range using the semi-elastic force applied to the primary pulley 1 and the elastic force applied to the secondary pulley 2. In the present invention, the pressure application devices 10' and 20 is capable of individually regulating the speed-change displacement 1r of the movable disks 1a and 2a and the compressive displacement 1t of the elastic body, respectively. Accordingly, the transmission torque of the primary and secondary pulleys 1 and 2 can be further compensated for the secondary instructions St_1 and St_0 that determine the frictional force upon changing speed. In the low-speed range, the primary pulley 1 has less frictional force while the secondary pulley 2 has excessive frictional force. Thus, an amount of compensation ΔSt_1 may be added to the inputted secondary instruction St_1, and an amount of compensation ΔSt_0 may be subtracted from the outputted secondary instruction St_0; however, either one will do. In addition, in the high-speed range, the primary pulley 1 has excessive frictional force while the secondary pulley 2 has less friction force. Therefore, on the contrary the above, for example, an amount of compensation ΔSt_1 may be subtracted from the inputted secondary instruction St_1 while an amount of compensation $\Delta S't_0$ may be added to the outputted secondary instruction St_0. In either cases, the pressure sensors 94 and 95 attached to the pressure application devices 10' and 20 can accurately perform a variable pressure control using negative feedback control for reduction in the efficiency. FIG. 7B shows the effects of the compensation in the low-speed range and the high-speed range in the forward mode transmission operation by dotted lines placed on both the sides of the top of the characteristics T_D. Consequently, as shown in Fig.

7B, this means that a range width of the entire variable-speed range is enlarged from BD1 to BD2.

[0070] (III) Reverse Mode Transmission Operation in the Overall Speed-Change Range:

[0071] In the case of the reverse mode transmission operation in the overall speed-change range, the compensation for the frictional force in the low-speed and high-speed ranges can be carried out according to the same procedure as that of the above. FIG. 7B shows the effects of the compensation in the low-speed range and the high-speed range in the reverse mode operation by dotted lines placed on both the sides of the top of the characteristics T_R. The details of this procedure are the same as those of the above description (II) practically and the description thereof will be omitted. In this case, consequently, the range width BR1 of the variable-speed range is also enlarged to BR2 as shown in FIG. 7B. The most important point resides in that, in any case of (I) to (III) described above, when individually controlling the elastic force of both the primary and secondary pulleys, the semi-elastic force applied along with the pressing force of the reference pulley should be not increased over the amount of elastic-frictional force of the follower pulley so that the speed-ratio determined by the reference pulley function is not affected by the semi-elastic force. Under such constraints, in order to improve the efficiency even further, it is necessary to positively give bending ability or elasticity in a width direction to the belt for enlargement of a continuous contact area. Alternatively, it is necessary to change the material of the frictional surfaces that increases coefficients of friction relative to the pulleys. In addition, the input torque T_1 is reduced by the speed ratio ~~E~~ ϵ of the output torque T_0, resulting in $T_1=T_0/\epsilon$, theoretically; however, in practice, the coefficients of friction varies with the applied pressure, which does not satisfy the above equation sufficiently. Accordingly, it is necessary to empirically select the amount of elastic force when regulating the output torque based on the input elastic force, and select the spring constants or the like of the two elastic bodies 51 and 61.

[0072] In the present embodiment, the switching of the functions and the individual compensation regulation are described separately. However, in practice, all the operations described by the above items (I), (II) and (III) are performed at the same ~~time~~ machine, to extend the speed-change range ~~B_0~~ BD_1 or BR_1 to B_1 , B_1 to B_2, BD_1 to BD_2, and further ~~B_2~~ BR_1 to BR_2, respectively, as shown in FIG. 7B. In addition, averaged high-effective transmission ability

can be realized as characteristics T_0 shown in FIG. 7B, which is performed in combination with forward mode and reverse mode characteristics TD and TR applied to torque compensation. Additionally, in the present embodiment, the control in which the semi-elastic force used during the reference pulley function follows the elastic force of the follower pulley function is performed in conjunction with the control in which the semi-elastic force is positively used for the compensation. In practice, since the variable-speed transmission itself is carried out even if the semi-elastic force is not applied, most of the semi-elastic force is used for the regulation to compensate for the frictional force. In some cases, the switching of torque is not carried out smoothly when the functions are switched. In such cases, after the semi-elastic force capable of smoothly switching the functions is used momentarily, the functions of the pulleys may be switched. At that time, the secondary instruction that is supplied to the motors 76 and 78 may be a fast-motion instruction that supplies multiple pulses to the motors 76 and 78 in a short time. By the way, a car or the like moves at a low-speed when putting it in the garage. At this time, it is necessary to highly compress the elastic body. While the car halts, the elastic body is in a highly compressed state all the time. Therefore, the secondary instructions St_1 and St_0 as compensation instructions may be supplied to forcibly remove the compressive force applied to the elastic body.